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Process and technology challenges in swift-starting virtual teams

Bjørn Erik Munkvold [a,*], Ilze Zigurs [b]

[a] *Department of Information Systems, Agder University College, Serviceboks 422, 4604 Kristiansand, Norway*

[b] *College of Information Science & Technology, University of Nebraska at Omaha, 6001 Dodge Str., PKI 284E, Omaha, NE 68182-0116, USA*

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Abstract

Virtual teams often face tight schedules and a need to start quickly and perform instantly. The goal of our study was to enhance understanding of the challenges faced by such teams. We used time–interaction–performance theory as the framework for following the processes and functions within virtual teams working on a systems development task. Our study provided a detailed examination of the group process, applied to virtual teams working under time pressure. The challenges faced by virtual teams in such settings showed that teams must work to enhance their effectiveness in multiple dimensions.

Keywords: Virtual teams; *Ad hoc* teams; Systems development teams; Time–interaction–performance theory; Collaboration technology

1. Introduction

Virtual teams are important mechanisms for organizations seeking to leverage scarce resources across geographic and other boundaries. The urgent need for rapid team formation and performance suggested that research was needed to help understand the key aspects needed for success of virtual teams.

Virtual teams include a range of team types, from *ad hoc* to more permanent structures [26]; however, given the prevalence of dynamic change and the importance of rapid resource mobilization, we chose to focus on *ad hoc* rather than permanent ones. They are formed in response to specific needs and typically must perform quickly [6]. Therefore, they need rapid start-up and we shall call them *swift-starting teams* consisting of professionals who have no prior knowledge of others on the team and who must work together immediately [18]. They are particularly interesting because the rapid combination of disparate resources creates a challenging environment for success.

We devised a study to examine the phenomena, choosing systems development as the task because of its ubiquity and importance, and using an educational setting for the context because of its convenience as a useful and acceptable way to study virtual teams [5,10,13,25,27].

Our research questions were:

(1) What patterns, practices, or types of activities must swift-starting virtual teams carry out to achieve effective process and outcomes?
(2) What types of process structure and technology support should be provided for facilitating such teams?

* Corresponding author. Tel.: +47 38 14 17 72; fax: +47 38 14 10 29.
E-mail address: Bjorn.E.Munkvold@hia.no (B.E. Munkvold).

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2. Theoretical framework

2.1. Factors affecting virtual teams

A virtual team typically has team members dispersed geographically, possibly with different times, organizational affiliations, and cultures [4]. In general, the greater the dispersion or discontinuity, the more virtual the team [32].

For purposes of our study, we defined a virtual team as a collection of geographically and/or organizationally dispersed individuals who communicated via computer-based technology to accomplish a defined task [30]. In particular, reliance on computer-mediated communication makes virtual teams unique from traditional ones. We view virtuality as a continuum rather than a dichotomy, and its degree depends on the extent to which the team is dispersed. Accordingly, we make no assumption about the temporal dispersion of the team. A swift-starting team is a team of professionals who must cooperate over a short time period to complete a task that requires improvisation, self-organization, and rapid results.

A large number of empirical studies have been conducted in educational settings with students working on relatively realistic tasks (e.g., [12,23,24]). Educational settings allow for control of aspects such as setting the team configuration, task, and technology. Thus, such studies are often called ''field-based quasi-experiments'' [11].

Our initial review of empirical studies on virtual teams found that research on short-term teams (with life spans less than 6 months) had been conducted almost exclusively in educational settings. Their key findings were representative of the broader base of empirical research. Table 1 summarizes key findings from prior research in terms of factors that contribute to virtual team outcomes.

A general problem with comparing and aggregating findings from the research on virtual teams is the great variation in research design and context. Thus the factors considered should be interpreted as indications only, depending on the particular case. For example, cultural diversity was reported to have a negative effect on project outcomes in only one of these studies.

The diversity of paths that virtual teams take to effective outcomes is a challenge when drawing general conclusions. Any theoretical model for examining teams must therefore take into account group diversity.

2.2. Theoretical model

We adopted a process model for our theoretical frame. Time–interaction–performance (TIP) theory [17] provides a useful and rich way of understanding both consistency and variation in group process and outcomes. It is useful because it focuses on multiple dimensions of group activity over time, allowing different aspects of communication and process to be examined in more depth than simple contingency or factor theories. The theory is rich, because the combination of each stage and dimension involves its own set of concerns and concepts. In addition, no optimal path is prescribed; instead, different contexts and group characteristics are expected to result in different paths.

The theory combines a phase perspective on group development with an all-important attention to different dimensions of group orientation. Group members are expected to act in four modes, which represent phases of problem solving, and they engage in three functions which represent levels of the systems to which group members make contributions. Fig. 1 expands the basic elements of TIP theory to show specific definitions and examples of each mode/function cell, as defined by McGrath. A given team is expected to find its own path through the problem-solving modes, with a different emphasis in each of the functions. The path taken by each team is a function of that team's characteristics and context, e.g., the complexity of the task or mutual understanding among team members. Indeed, the factors are precisely those types of elements that are expected to affect how a team works, through its interaction over time, to perform its task effectively.

Table 1
Factors with potential to affect outcomes in virtual teams (with example studies)

Potential to contribute to positive outcomes	Potential to contribute to negative outcomes
Ease of use of technology [5]	Time differences [28]
Trust among team members [5,10]	Mismatch in expectations [7]
Well-defined task structure [5]	Cultural differences [7]
Variation in experience levels (with respect to effectiveness) [8,26]	Variation in experience levels (with respect to efficiency) [7,28]
Acknowledgement and management of difficulties of virtual teamwork [15,27]	Lack of norms for communication [26,28]

MODE	FUNCTIONS: Production (contribution to system in which group is embedded)	Well-Being (contribution to group itself as a continuing social structure, i.e., relations among group members)	Member Support (contribution to individual members of the group, i.e., relations between individual members and the group)
Inception (goal choice)	Production Demand/Opportunity *(choose among opportunities or demands and initial performance strategy)*	Interaction Demand/Opportunity *(choose among interaction opportunities and demands)*	Inclusion Demand/Opportunity *(choose to participate or commit to the project)*
Problem Solving (means choice)	Technical Problem Solving *(determine how to carry out the project)*	Role Network Definition *(decide who will do what, when, and with whom)*	Position/Status Attainments *(choose position or role)*
Conflict Resolution (policy choice)	Policy Conflict Resolution *(resolve conflicts of preference, value, or interests)*	Power/Payoff Distribution *(resolve political issues of interpersonal status, power, payoff)*	Contribution/Payoff Relationships *(negotiate expected contributions and payoffs)*
Execution (goal attainment)	Performance *(carry out project goals)*	Interaction *(interaction to carry out interpersonal activities)*	Participation *(choose concrete participation in activities)*

Fig. 1. Expanded view of TIP theory [17].

3. Research method

We used a qualitative approach to analyze the process characteristics and challenges experienced by swift-starting virtual teams [19]. Thus, our study was exploratory: rather than testing theory, we attempted to generate an understanding of the process activities of teams and how their activities affected the outcomes. The unit of analysis for our study [31] was thus the communication and process activities of virtual teams.

3.1. Project overview

We conducted a 2-week study of university-based virtual teams that were required to carry out a systems design project. The project was part of the course requirements for graduate students in two universities, one in Norway and the other in the United States. The student teams represented *ad hoc*, international systems development teams working under time pressure. Team members could not meet face-to-face as an entire team and communicated primarily through an intranet that included collaboration tools chosen by the team members.

Participants were graduate students in Information Systems programs at the two universities. Five teams participated, with four of the teams consisting of two students from each location, and one team that had three Norwegian students and two U.S. students. In addition, due to a larger number of students in the Norwegian course, two all-Norwegian, four-person teams were formed, consisting of students located in two different cities in Norway. Team composition also differed somewhat with respect to full-time *versus* part-time students. The U.S members were mostly part-time. The Norwegian members were mostly full-time; they collaborated face-to-face more often than did the U.S. students by working on the project while on campus. In comparison, some of the U.S. team members did not meet at all during the study. Thus the teams were not on the extreme end of the continuum of virtuality, consistent with typical organizational practice [1]. Even so, none of the teams conducted face-to-face meetings with all members present.

Participants had little or no experience with virtual projects. Approximately one-third of the participants reported previous experience with virtual communication in coursework, having used e-mail or collaboration tools such as instant messaging, chat, etc. Only one student had experienced a virtual project while working.

Table 2 shows the specific steps in the project from a participant perspective.

3.2. Task deliverables

The task for all teams was to design a system; it was intended to be fuzzy [2], complex and require extensive discussion and negotiation among team members, having multiple possible outcomes and no single correct answer [33]. Team members were asked to develop a high-level design of a support system for the

Table 2
Overview of project steps from participant perspective

Step	Timing	Individual or team	Description
Receive orientation and instructions	Two weeks before start date	Individual	An orientation and instructions document was e-mailed to all participants by the instructor in the respective course
Fill out pre-session questionnaire	Start date	Individual	Questions asked about demographics, experience with virtual teams, and expectations for the project
Sign up on intranet	Start date	Individual	Instructions for signing up were provided by e-mail
Communicate with team members and develop deliverable	Two-week period from start date	Team	The intranet provided the teams with a portfolio of tools for communication and information sharing. No instructions or user training were provided. Each entry in the intranet was saved in an intranet log
Access help desk as needed	Two-week period from start date	Individual	Help desk was implemented as an e-mail address that was monitored by the course professors
E-mail design report to course professor	End date (2 weeks after start date)	Team	Design report required documentation of systems functions, system data, communication design, and interface design
Fill out post-session questionnaire	End date	Individual	Questions asked about perceptions of the experience
E-mail experience report to course professor	One week after end date	Individual	Experience report required description of the team's working process and reflection on positive and negative experiences from the project

Olympic Games. It was to be an information and communication system for officials. General requirements were stated in terms of desired capabilities, e.g., one-to-one and one-to-many communication, virtual meetings, access to information about events, and access to scheduling information. Each team acted as a group of consultants bidding for the job of developing the system; each was asked to provide a creative solution based on their judgment and the expertise of their members. Teams were not expected to decide on the actual tools to be used, but only to provide a design of the functionality and data of the system. An e-mail address for communicating with the client was provided. The authors, who were the instructors of the classes in which participants were enrolled, played the role of the client; they did not participate in the team interaction, other than answer questions.

Two deliverables were required:

(1) a design report that provided system functions (including a context diagram), system data (including a high-level entity relationship diagram), the communication design, and the interface design;
(2) a report that provided team members' experiences during the project.

The teams were given 2 weeks to complete the design report, working in distributed mode during the entire project.

While many large-scale development projects have very structured and carefully defined steps, a "quick start" on requirements is consistent with agile types of development methods. The first author had been responsible for developing a sales support system for the Norwegian telecom vendor during the 1994 Lillehammer Winter Olympic Games: a quick requirements analysis had been essential for meeting the tight project schedule for developing a system to be used only during the Olympics. Further, collaboration tools are increasingly being used to support distributed software development projects [3].

3.3. Technology support

We created a separate intranet for each team, using a trial version of a commercial, Web-based intranet

product (www.intranets.com at the time of study; now part of www.weboffice.com). The intranet provided the following capabilities: document management, discussions, tasks, polling, group calendaring, e-mail, and instant messaging. (See http://www.weboffice.-com/EN/Services/Workgroup/ for details of the tools provided, including screenshots.) It was not our intent to test the claims of a particular commercial product, but instead to use a representative example of a set of integrated and flexible tools that teams could use relatively easily and for a variety of tasks [22].

Team members were instructed to communicate only through their intranet. No training or instructions on how to use the intranet were provided. The ability to choose from a set of tools was deliberate (to examine how teams dealt with the environment and were able to structure their work). Fuzzy tasks require good support for communication and information processing and effective support for process, which should be flexibile in the way that groups can structure and use the tools [34]. Thus, the technology provided for the teams was consistent with guidelines for the support requirements for this type of task. In addition, the tools were intended to help virtual teams perform fast and effectively.

3.4. Data collection and analysis

Altogether 29 students participated in the project (21 in international teams, and 8 only Norwegian). Data inputs were from pre- and post-project questionnaires, experience reports, and intranet logs. The experience reports produced by participants were approximately three pages each and were treated confidentially by the instructors. The intranet log was used to determine frequency of intranet use as well as to store the actual discussion entries.

Data analysis focused primarily on the experience reports, with the intranet log and questionnaire data providing complementary results related to participant expectations, experiences, and technology use. Experience reports were analyzed for themes related to the issues investigated in our study, i.e., the modes and functions of team interaction, and the team's use of technology support tools. TIP theory was the framework for structuring the analysis of team interaction, mapping the contents of the experience reports to different modes and functions of TIP. Analysis of technology use focused on the teams' experiences with the different collaboration tools and how they affected the interaction.

4. Analysis and discussion

We analyzed the modes and functions of team interaction using TIP theory, based on the experience reports. Quotations from the experience reports amplified our findings. To ensure anonymity, the quotes are identified only at the team level.

4.1. Modes and functions of team interaction

We analyzed the teams' experiences during the project in terms of the four modes of TIP theory: inception, problem solving, conflict resolution, and execution.

4.1.1. Inception: choosing among opportunities and demands

The inception mode is the starting point for team performance: in it, team members choose what they will do in terms of task accomplishment, group relations, and member contribution. Attention to this mode may be difficult in virtual teams, given the lack of structure. The following expectations reported by one of the students prior to the project start proved prescient with respect to the process experienced by most of the teams:

> "To brainstorm how to start this deliverable is going to be difficult. Someone will throw an initial idea out, probably over e-mail, and then wait for someone to reply. Just waiting for everyone to respond and then to figure out how to get started will probably take a couple of days or more. I would guess that we will be scrambling to get the deliverables done the last day or two of the project. I feel the deliverable will be of lower quality than it would be if this were done face-to-face, simply because it takes so long to get things organized via a tool of this nature. My responses would be different if we were to add in one telephone communication. For example, the project should be started and brainstormed with teleconferencing. After the deliverable is understood and agreed upon by the team, then the tool would be beneficial in reaching the project's goal. But to start from scratch with the tool, that is where I see the problems." (Team 5)

In spite of the short deadline for the deliverable, most of the teams reported a slow start-up phase. All five international teams encountered problems, with one or more members signing on to the intranet late in the project period. The most extreme case was one member who did not contact other team members until 2 days

before the project deadline. The Norwegian students tended to be first movers, most possibly due to the different working conditions of the two classes. The Norwegian students were anxious to get the project going, while most of the U.S. students were working full time and therefore needed to coordinate the project with their job responsibilities. The experience reports also reflected rather different orientations towards the project by these two categories of students. While the full-time students saw this project as their major task during the time period, the part-time students scheduled the project as an intensive task to be conducted towards the end of the project period. As one of the part-time students said:

> ''This writer's style is to work on projects as conditions demand and this writer had pressing outside demands, not the least of which was his employment. This writer had budgeted the time to spend on this project the last few days before it was due. This was not unprecedented because another group member had informed the group that she could work on the project only during the first part because of pressing outside commitments.'' (Team 2)

In this team, a problem arose because the member did not communicate his ''time budget'' to the group. This failure to communicate or discuss different orientations and schedules early in the project resulted in frustration and conflict, especially among those who signed up early and expected a joint effort during the entire period. Sometimes the rest of the team was not sure how to approach the laggards without being offensive:

> ''We wanted to be polite, and we were a bit worried if it would be rude to ask him to join us only a few days after the project had started.'' (Team 4)

In the inception mode, it appeared that teams generally focused on the production function, with little attention to team member well-being or support. Little explicit discussion occurred about the level of commitment to the project in the early phase, nor did teams deal with the idea that they should become ''one'' team rather than two subgroups. Thus, these teams made the all-too-common mistake of focusing on task activities in the inception mode to the exclusion of team development. Though the importance of the socio-emotional or team development aspects of team functioning has been recognized for years, even in structured meetings with established procedures there is often insufficient attention to team development [16].

4.1.2. Problem solving: choosing means

Problem-solving requires choices between the possible ways to approach the task: the content, the activities of people in the team, and the roles of the individuals. In our project, none of the teams assigned any formal roles or responsibilities. Rather, the team structure and roles evolved gradually, with the members from each course or location forming natural subgroups. In fact, some teams referred to themselves as ''two groups.'' Even the two all-Norwegian teams working from different locations considered themselves to be separate subgroups. Whether or not this phenomenon ultimately affected the outcomes, however, is not clear from our data.

Leadership often became associated with those taking the first initiative:

> ''From the beginning, I felt as though our members from Norway wanted to lead the project and it may have been that they were just anxious to begin.'' (Team 4)

> ''It seems as though our Norwegian members were able to get the group going in the right direction, as one of the members over there kind of took the facilitator role.'' (Team 1)

In some cases, team leadership shifted during the study, because of the level of contribution to the team project. For example, in one team, one of the U.S. members took charge by posting a ''completed project'' to the intranet. The other team members, who had not been consulted, rejected this posting as ''final'' but decided to build on it as a start. One Norwegian member appeared as the team leader during this process. With only 3 days left before the end of the project, one U.S. team member was threatened with exclusion since he had not, at that time, contributed to the project. However, this member then managed to convince the rest of the team that he would be able to improve the final result by conducting a rewrite. Thus, he became the leader during the final stage of the project. These cases showed struggles in defining the appropriate roles while the teams attempted to find how to carry out their work under pressure.

In terms of the production function, most of the teams delegated tasks between the two subgroups and then integrated the pieces into a common solution during the final phase of the project. This approach was not without its problems. Several teams reported that it involved compromises, resulting in a final product which was less than optimal:

> ''The final product is not the product we thought it should be. Lack of time combined to lack of

progress, results in many compromises. We used some models and text that we had produced and mixed it with some of the other group's results. That way both groups contributed to the final report, but probably none of them is satisfied with it. The report has probably some lack of consistency because of this. We wanted, of course, to make a better, and more consistent report. But on a group project you sometimes have to take some solutions that you don't like.'' (Team 6)

In some cases, a team also ran out of time, leaving one of the subgroups with the task of integrating the solution and report without the other subgroup seeing the result. Such problems of integration were as great for the two all-Norwegian teams as for the international teams.

Team 5 chose a different strategy from the others. Instead of delegating different parts, they worked together on the entire project, working step-by-step through the requirements by focusing on one area of the design report at a time. This strategy seemed to affect the project positively, since the design report delivered by this team stood out as the most integrated of the reports in terms of both content and format.

4.1.3. Conflict resolution: preference, politics, and contributions

Conflict resolution helps team members resolve problems related to the task, interpersonal issues, and contributions to the team. Not surprisingly, several teams experienced conflict during the study. The parties in conflict generally were the subgroups at each physical location. This ''polarization'' between team members has often been reported in computer-mediated communication [29], apparently resulting from a sense of ''us *versus* them'' between the subgroups. In some cases, conflict occurred between a team member who was late to sign up and the rest of the team. Conflicts, however, mainly revolved around different interpretations of the project task and deliverables, disagreements on the preferred schedule, and disputes about the relative contributions made by each subgroup.

The main cause of conflict seemed to be in the problems of communication. Instead of starting with a structured discussion and planning the team project, the teams generally started rapidly on the tasks after splitting them among the subgroups. Clearly, the teams paid insufficient attention to the earlier stages. Such problems were exacerbated by the asynchronous work mode imposed on the teams (different time zones and limited synchronous tool support). The following quote exemplifies the communication problems:

''The problem of ''differing interpretation'' of our posted intranet messages caused the different pieces of our project to be out of sync. For instance, one team member asked initially if athletes' travel arrangements (flight, rental car, hotel) should be available through the system. Other team members interpreted travel arrangements to mean a travel guide describing how to get from one location to another location. Since it was not clear that different interpretations existed until a review of the final product, many changes had to be made (near the deadline) in order for the final paper to ''agree'' on a core set of functionality and be consistent.'' (Team 3)

Communication conflicts often manifested themselves in misinterpretations and questioning of contributions made by fellow team members. The team member who had made his first move by posting an entire project draft to the team intranet explained how his initiative was misinterpreted by the team:

''I feel that the main negative experience was not being able to communicate exactly what we wanted to say. I was personally involved in this and it makes you want to steer away from any other projects like this. I had posted all of the parts to the assignment on the site but had labeled it ''Completed Project.'' Some of the other members took offense to this because of the wording. All that was meant by the wording was that all five parts were there. The other members took it to mean that the project was done and they weren't going to be allowed to do anything. Most of the disgruntled members worked it out in the beginning but by not being able to talk and hear voices, there was a misunderstanding.'' (Team 2)

A similar experience was reported by one of the all-Norwegian teams:

''The evening when the project place was started three of us logged on to it, but we hardly had any communication at all. Before the two of us from [Location A] had a chance to meet each other, the students in [Location B] started to work on the project without us knowing. Their ideas were put onto the documents page. We had our meeting, and agreed that we needed to discuss some important issues with [Location B] before we could get started. These we posted onto discussion. Before [Location B] understood our need for discussion, new documents arrived. Now we were getting frustrated and almost mad. When we were able to talk to the students in [Location B] per telephone things got

better. We then discussed issues and agreed on how to work on.'' (Team 6)

Communication challenges also affected team negotiations: the team setting was perceived as leading to a stronger personal ownership of work:

''Trying to convince someone proved to be very hard. In fact much harder than it would be in a ''real life'' setting. In a virtual project setting, it seems that each participator gets a stronger feeling of ownership to the work this participator has done and sometimes defends his/her work beyond reasonable limits. The group dynamics in a virtual project is very different from a ''normal'' group, and can cause problems for people inexperienced in this type of collaboration.'' (Team 7)

Some of the students mentioned cultural differences as a possible explanation for the challenges and conflicts they experienced. However, differences in the students' work context and educational background seemed to be more influential than cultural aspects. The challenges caused by differing educational backgrounds were mainly related to different training in data modeling and software development, resulting in some basic disagreements on diagrams.

The impact of different backgrounds was also supported by observations from the two all-Norwegian teams. Despite being enrolled in the same course in the same program of study, differences in undergraduate background were felt as strongly for them as for members of the international teams:

''It was a bit annoying that we didn't know all the team members' background. How should we express ourselves in messages to the team when we didn't know their competence?'' (Team 6)

The problem of building trust in a virtual setting was an underlying issue in most of the experience reports; see the following statement:

''Trust is a fundamental condition. Trust is something that is hard to accomplish when the participators don't know each other. Trust is also something you earn over time, by doing the ''right thing''. If the trust is broken at an early stage of the virtual collaboration it is also very hard to regain. In a virtual project, people are recognized to a greater extent for what they deliver, and it is harder to make up for a bad first impression.'' (Team 7)

Conflicts and negative experience carried over to the participants' general perception of a virtual teamwork as something they would avoid if they could:

''The misunderstandings that can come from a distributed project are not worth the effort to participate.'' (Team 2)

Even so, most students also felt that the virtual project was a useful learning experience that better prepared them for their work. The results from the pre- and post-project surveys reinforced this perception of value: the students' pre-project expectation was that the project deliverable and conduct of the team's process would be slightly worse than if they had been co-located during the project, but the post-project perception was somewhat more in favor of virtual work.

In general, the results showed that conflicts due to the production function were not as much an issue as those in the member support function, and, to a lesser extent, the well-being function. Specifically, with respect to member support, teams needed to pay much more attention to negotiating their expected contributions.

4.1.4. Execution: performance, interaction, and participation

The final mode of TIP theory, execution, occurs when teams carry out project goals through effective interaction and participation. The experience reports indicated that most of this took place in the second week of the project, although some teams managed to perform more evenly throughout the time allotted. In the extreme cases, the whole team was only operative in the last few days before project completion, due to one or more members being late in joining the discussion.

Project reports were evaluated by the instructors and were a part of the grade in the courses. Since the key goal of the project, from a course perspective, was to provide students with training in virtual teamwork, more attention was paid to process than outcomes in the grading. Nonetheless, we found substantial variation in the project reports. Although the task description given to the teams specified the overall structure of the report, they varied in the scope of the solution, level of detail and clarity, and sophistication and level of detail in the diagrams. While some teams kept strictly to the core functionality specified in the instructions, others chose a more creative approach with additional services; e.g., two teams included information for user groups other than Olympic officials (spectators and the media). These design decisions were made without any consultation with the clients, as represented by the instructors.

Despite being provided with examples of context and entity-relationship diagrams in the instructions, the teams were not consistent in their use and notation in the design reports. This reflected a variety in prior courses

taken by team members. Some reports also gave the impression of being a compilation of contributions from each team member or subgroup, rather than being integrated. This was confirmed by the teams' own assessment of the product.

Some members discussed how they brought different qualities to the project that complemented their efforts—an aspect that was cited as one of the main benefits:

> ''The Norwegians seemed to bring to the table a superior grasp of the diagramming side of the project. Yet the Norwegians were noticeably deficient in the writing aspects. Therefore, it can be said that our strengths and weaknesses were compatible, and our final product was comparably stronger than if we had done it alone.'' (Team 3)

A problem, however, was that few of the teams explicitly discussed members' backgrounds and skills in detail before delegating work tasks. Thus, the teams did not exploit the possibilities of complementary skills:

> ''The work could have been more efficiently done if the team members had used their time on tasks they felt more comfortable doing. That could have saved time.'' (Team 4)

In general, the production function was dominant during execution. Interaction and participation were limited to coordination and clarification related to task execution and the fulfillment of responsibilities that had been negotiated earlier. However, several teams experienced problems with one or more team members signing up for the project at the last minute, resulting in a need to revisit previous modes quickly in order to renegotiate performance strategy and work allocation. Obviously, there was little room for contributions to team relations in the final stage of the project.

4.2. Technology use

The intranet log showed a generally high level of intranet use by most teams, with close to 100 visits per team during the 2-week project, or an average of 23 visits per student. However, the number of visits varied considerably among students (from 6 to 34), even within the same team. Table 3 summarizes the teams' use of, and experiences with, the different intranet tools, based on the experience reports. The table shows the relative level of use by teams, with progressively less use from ''Extensive'' to ''None.''

All teams started using the intranet as the only tool for communication and information sharing, as specified in the project guidelines. However, due to different problems with the communication tools, all but one of the teams decided to use one or more external tools: their regular e-mail service, instant messaging, or telephone. One of the all-Norwegian teams even reverted completely to using regular e-mail and the telephone to be able to complete the project on time. The overall assessments of the intranet technology were mixed. Only two teams were positive in their evaluation (the intranet tools provided appropriate support for this project). The remaining teams reported problems and frustrations resulting from perceived inadequacy and limitations in various tools.

The document repository and discussion board were the major tools used, with others being used much less. Yet team members reported problems even with these two services. An overall problem was the issue of user interface and navigation among different tools. Teams encountered difficulties in obtaining an overview from the main page and in locating new issues and documents on the discussion board:

> ''The intranet.com application was sufficient, but it seemed to be too cluttered. In our experiences, we

Table 3
Use of and experience with intranet tools

Intranet tool	Relative level of use	Experiences
Document repository	Extensive	Useful for storing and sharing project documents. Some problems with update and notification of changes
Discussion board	Extensive	Main tool for team communication. Some problems with structure and navigation of discussion trees
E-mail	Little	Lack of integration with normal e-mail resulting in migration to standard e-mail as separate tool
Instant messaging/chat	Little	Use restricted due to different time zones and lack of multi-part IM/chat function
Contact list	Some	Mixed perceptions about usefulness. Used in some teams only
Other tools: vote, polling, tasks, calendar	None	No felt need for these tools in this (small-scale) project

had a multitude of forums open without a great deal of proper naming. Also, it seemed like participants were discussing the same topics in different forums so that the separated forums didn't even matter. Maybe this problem could have been fixed if we would have been more disciplined in defining what was to be discussed in which forum. The application also was tough, at least at first, to navigate through. The individuals' thoughts were sometimes hidden behind things and you had to pay attention where ideas were because it was often hard to find them again.'' (Team 3)

Several participants pointed out the challenge of establishing structure and discipline for effective use of the flexible tools on the intranet. Although the intranet was the communication tool for most teams (e.g., referred to as the ''nerve center'' of their communication in the experience report), several people found it difficult to use effectively:

''It would sometimes be a problem navigating between discussions, the logical structure of the discussion-pages led to some misunderstandings. Even though a reply was made to a discussion topic, other group members sat waiting for replies because of poor design.'' (Team 7)

Documents could not be edited simultaneously within the intranet; they had to be downloaded, edited offline, and uploaded as a new version. Several teams reported that the ''information pull'' mode of using the document repository and discussion board was too slow, and they found it more effective to use e-mail for sending information among team members. However, teams found it difficult to use the intranet e-mail, due to problems with integrating it with their regular e-mail accounts. Also, since some team members did not log on to the intranet until the final days before completion time, using external e-mail was the only way for sending messages. Thus, all teams but one returned to using regular e-mail accounts.

Several barriers were reported related to both accessibility and functionality for the instant messaging tool. Different time zones (combined with part-time work) made it difficult to schedule times for synchronous communication. Some students found it difficult to use the tool behind their firewalls at work. Lack of functionality for multi-part chat and for logging communication sessions further restricted IM use:

''We were on three different locations, this resulted in every person sitting with two Instant Messaging windows, copying and pasting messages between them to get all messages available to everyone. The Instant Messenger did not log our discussions, and it was not possible to copy and paste messages already submitted, this made it very difficult to refer to earlier discussions and to save discussions.'' (Team 7)

Similar problems were reported when trying other IM tools. MSN Messenger was used by one Norwegian subgroup. In another team, the Norwegian team members reported being uncomfortable having to chat in English.

The Contact function was used by some teams and found to be useful for providing an overview of team members and their contact details, contributing to relationship building:

''One interesting observation was how fast and easily this technology allowed the team members to become acquainted. Although there was never any face-to-face meeting, I felt very connected with my team members.'' (Team 4)

One of the teams also posted pictures of their members, together with personal background.

Perceptions about the different tools varied among members of the same team. The description of technology use showed that teams were not able to use all the flexibility of the intranet tool. Contributing factors included the short time frame of the project, lack of explicit guidelines and training, and limitations of the tool.

4.3. Factors influencing team process and outcome

Table 4 compares the outcomes from our research with the potentially positive contributing factors while Table 5 provides the comparison of potentially negative factors. We concluded that few of the potentially positive factors were evident in our study while all but one of the negative ones were cited. The flexible environment was deliberately provided via a set of tools that team members could choose to use and combine for their own needs, but that flexibility was not handled well by the teams. The lack of experience with virtual teams may have been a contributing factor, but this only reinforces the importance of assessing these factors.

The particular team configuration of our project, with five international and two national teams, provided some opportunity to study any cultural effects [9]. Our results supported previous findings that differences in educational background and work experience represent a greater challenge for virtual teams than cultural

Table 4
Findings related to potentially positive factors

Factor	Outcome identified in current study
Ease of use of technology	Although each intranet service was considered fairly intuitive to use, integrated navigation among the services was not perceived as particularly user friendly. Combined with perceived limitations in some of the key services (e-mail integration, discussion lists, document repository), the technology received only a modest evaluation from most teams
Trust among team members	Teams did not succeed in developing trust, but instead struggled with polarization among subgroups at each location. Teams regarded the lack of an initial face-to-face meeting as a major cause for lack of development of trust
Well-defined task structure	Although teams were given detailed instructions for the project deliverable, the fuzzy nature of the task (defining functional requirements and technological infrastructure for the solution) caused some frustration among team members
Variation in experience levels (with respect to effectiveness)	Two of the international teams reported that team members brought different qualities to the project, e.g., diagramming skills *vs.* writing skills, and stated these differences to be a positive contribution to the project
Acknowledgement and management of difficulties of virtual teamwork	In the heat of this short project period, teams did not manage to analyze their experienced difficulties and take active measures for managing them. Instead conflicts remained submerged, with teams settling for compromises that none of the subgroups really appreciated

Table 5
Findings related to potentially negative factors

Factor	Outcome identified in current study
Time differences	Time differences restricted the possibility for synchronous interaction in the international teams, making coordination difficult. This problem was further amplified with the part-time *vs.* full-time status of the student groups
Mismatch in expectations	Mismatches in expectations about when and how much the team should work affected the project outcome negatively for most teams. This problem was ascribed mainly to the issue of full-time *vs*. part-time student status
Cultural differences	Cultural differences were not brought up as an issue, except for one of the teams reflecting that Norwegian students may be more accustomed to a direct tone which could be regarded as rude by U.S. team members
Variation in experience levels (with respect to efficiency)	Different backgrounds in data modeling and diagramming techniques from undergraduate courses complicated team work, both for international and all-Norwegian teams
Lack of norms for communication	Norms were a major problem for most teams, resulting in varying expectations for communication frequency and deliveries, and related frustrations

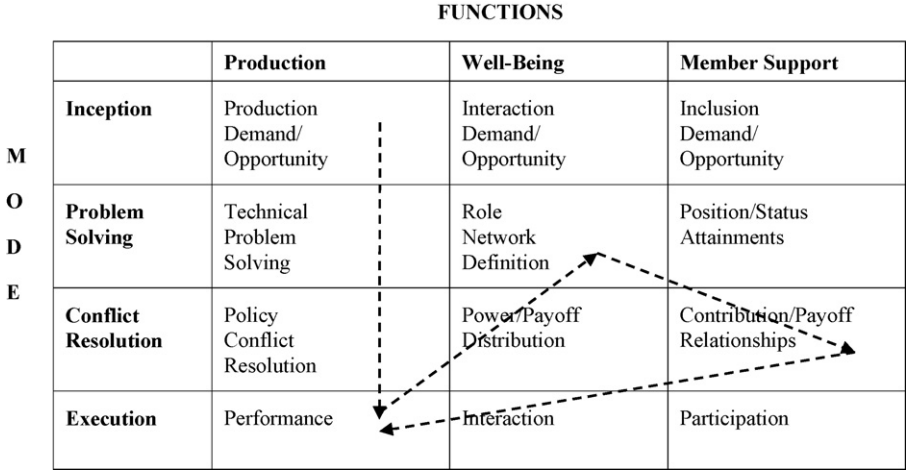

Fig. 2. Typical process path identified in the study of swift-starting virtual teams.

diversity [8]. The lack of nonverbal cues in electronic communication, combined with an asynchronous mode of communication, can reduce the salience of differences in cultural backgrounds and increase perceived similarity among participants.

Fig. 2 shows the TIP modes and functions with an overlay of the path that most of our teams followed. Our analysis of the teams' interaction in terms of TIP theory showed that these *ad hoc* virtual teams focused on the production function during the inception and problem solving modes, with less attention to the well-being and member support functions. Lack of attention to the other two functions created problems and conflicts in communication, coordination, and a mismatch in expectations. These problems affected the execution mode negatively.

5. Implications and conclusions

We have shown the challenges faced by swift-starting virtual teams working on a systems development project. We deliberately ran our study in an educational setting, which allowed us to perform an in-depth study of the interplay between factors such as the team, task, and technology in a controlled setting. The process experienced by *ad hoc*, virtual student teams has many similarities with the team formation stage in *ad hoc*, virtual teams in organizational settings. The students face challenges of coordination and technology support that are similar, though not identical, to virtual teams in industry.

The teams experienced a range of negative outcomes: lack of an integrated product, lack of ownership of the final result, lack of team bonding and commitment, polarization of some members, and trust problems. All teams believed that many problems could have been eliminated or reduced through an initial face-to-face meeting [14,21]. This practice is common in industry today, for example in the kick-off for distributed engineering projects [20]. However, there are cases, such as outsourcing, where it is not feasible to bring all team members together. Then, team members must attempt to become familiar with one another, which in TIP terms involves more focus on well-being and member support functions.

The use of TIP theory to analyze team process provided a multi-dimensional view of a team's path and helped show alternate paths through the problem-solving modes with different emphases on group functions. Swift-starting virtual teams need to structure their interaction from the onset, including introducing team members' background and competence, discussing project goals and deliverables, defining roles and responsibilites, and setting milestones. Similarly, they have to pay immediate attention to familiarizing themselves with and integrating available technology, and agreeing on preferred communication media and frequency. If teams do not pay immediate attention to these essential issues, they will not be able to achieve their potential.

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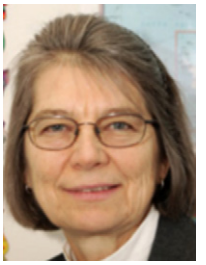
References

[1] R. Anson, B.E. Munkvold, Beyond face-to-face: a field study of electronic meetings in different time and place modes, Journal of Organizational Computing and Electronic Commerce 14 (2), 2004, pp. 127–152.
[2] D.J. Campbell, Task complexity: a review and analysis, Academy of Management Review 13 (1), 1988, pp. 40–52.
[3] J. DeFranco-Tommarello, F.P. Deek, Collaborative problem solving and groupware for software development, Information Systems Management, Winter 2004, pp. 67–80.
[4] L. Dubé, G. Paré, The multi-faceted nature of virtual teams, in: D.J. Pauleen (Ed.), Virtual Teams: Projects, Protocols, and Processes, Idea Group Publishing, Hershey, PA, 2004, pp. 1–39.
[5] H.K. Edwards, V. Sridhar, Analysis of the effectiveness of global virtual teams in software engineering projects, in: Proceedings of the 36th Hawaii International Conference on Systems Sciences, IEEE Computer Society Press, 2003.
[6] M. Engwall, C. Svensson, Cheetah Teams, Harvard Business Review, February 20–21, 2001.
[7] J. Favela, F. Pena-Mora, An experience in collaborative software engineering education, IEEE Software 18 (2), 2001, pp. 47–53.
[8] P.J. Guinan, J.G. Cooprider, S. Faraj, Enabling software development team performance during requirements definition: a behavioral versus technical approach, Information Systems Research 9 (2), 1998, pp. 101–125.
[9] G. Hofstede, Culture's Consequences: International Differences in Work-Related Values, Sage, Newbury Park, CA, 1980.
[10] S.L. Jarvenpaa, D.E. Leidner, Communication and trust in global virtual teams, Organization Science 10 (6), 1999, pp. 791–815.
[11] T. Kayworth, D.E. Leidner, Leadership effectiveness in global virtual teams, Journal of Management Information Systems 18 (3), 2002, pp. 7–40.
[12] K. Knoll, S.L. Jarvenpaa, Working together in global virtual teams, in: M. Igbaria, M. Tan (Eds.), The Virtual Workplace, Idea Group Publishing, Hershey, PA, 1998, pp. 2–23.
[13] K.R.T. Larsen, C.R. McInerney, Preparing to work in the virtual organization, Information & Management 39 (6), 2002, pp. 445–456.
[14] J. Lipnack, J. Stamps, Virtual teams: reaching across space, time and organizations with technology, John Wiley & Sons, New York, 1997.

[15] J.S. Lurey, M.S. Raisinghani, An empirical study of best practices in virtual teams, Information & Management 38 (8), 2001, pp. 523–544.
[16] J.E. McGrath, Groups: Interaction and Performance, Prentice Hall, New Jersey, 1984.
[17] J.E. McGrath, Time, interaction, and performance (TIP): a theory of groups, Small Group Research 22 (2), 1991, pp. 147–174.
[18] E.H. McKinney Jr., J.R. Barker, D.R. Smith, K.J. Davis, The role of communication values in swift starting action teams: insights from flight crew experience, Information & Management 41 (8), 2004, pp. 1043–1056.
[19] M.M. Miles, A.M. Huberman, Qualitative Data Analysis: A Sourcebook of New Methods, Sage Publications, Newbury Park, California, 1984.
[20] B.E. Munkvold, Implementing Collaboration Technologies in Industry: Case Examples and Lessons Learned, Springer-Verlag, London, 2003.
[21] B.E. Munkvold, L. Line, Training students in distributed collaboration: experiences from two pilot projects, Journal of Informatics Education and Research 3 (2), 2001, pp. 1–14.
[22] B.E. Munkvold, I. Zigurs, Integration of e-collaboration technologies: research opportunities and challenges, International Journal of e-Collaboration 1 (2), 2005, pp. 1–24.
[23] R. Ocker, J. Fjermestad, R.S. Hiltz, K. Johnson, Effects of four modes of group communication on the outcomes of software requirements determination, Journal of Management Information Systems 15 (1), 1998, pp. 99–118.
[24] S. Paul, P. Seetharaman, I. Samarah, P.P. Mykytyn, Impact of heterogeneity and collaborative conflict management style on the performance of synchronous global virtual teams, Information & Management 41 (3), 2004, pp. 303–321.
[25] A. Pinsonneault, O. Caya, Virtual teams: what we know, what we don't know, International Journal of e-Collaboration 1 (3), 2005, pp. 1–16.
[26] A. Powell, G. Piccoli, B. Ives, Virtual teams: a review of current literature and directions for future research, The Data Base for Advances in Information Systems 35 (1), 2004, pp. 6–36.
[27] S. Sarker, S. Sahay, Understanding virtual team development: an interpretive study, Journal of the Association for Information Systems 4 (1), 2003, pp. 1–38.
[28] S. Sarker, S. Sahay, Implications of space and time for distributed work: an interpretive study of US-Norwegian systems development teams, European Journal of Information Systems 13, 2004, pp. 3–20.
[29] J.A. Short, E. Williams, B. Christie, The Social Psychology of Telecommunications, John Wiley & Sons, New York, 1976.
[30] R. Tucker, N. Panteli, Back to basics: sharing goals and developing trust in global virtual teams, in: Proceedings of IFIP WG 8.2/9.4, 2003, pp. 85–98.
[31] R. Yin, Case Study Research: Design and Methods, Sage Publications, Thousand Oaks, California, 1984.
[32] Y. Yoo, M. Alavi, Emergent leadership in virtual teams: what do emergent leaders do? Information and Organization 14, 2004, pp. 27–58.
[33] I. Zigurs, B. Buckland, A theory of task/technology fit and group support systems effectiveness, MIS Quarterly 22 (3), 1998, pp. 313–334.
[34] I. Zigurs, B. Buckland, J. Connolly, E.V. Wilson, A test of task-technology fit theory for group support systems, Data Base for Advances in Information Systems 30 (3,4), 1999, pp. 34–50.

Bjørn Erik Munkvold is Professor of Information Systems in the Department of Information Systems, Agder University College, Norway. Dr. Munkvold received his PhD in Business Administration from the Norwegian University of Science and Technology. He has published in journals such as *Communications of the AIS, Database for Advances in Information Systems, European Journal of Information Systems, IEEE Transactions on Professional Communication*, *Information Systems Management*, and *International Journal of e-Collaboration*. He has authored a book entitled *Implementing Collaboration Technologies in Industry: Case Examples and Lessons Learned.* Professor Munkvold serves as Co-Editor of the Scandinavian Journal of Information Systems. His main research interests are implementation and use of collaboration technologies, and information systems research methodology.



Ilze Zigurs is Professor and Department Chair of Information Systems and Quantitative Analysis in the College of Information Science and Technology at the University of Nebraska at Omaha. She holds the Mutual of Omaha Distinguished Chair of Information Science and Technology, and also served as the founding Director of the doctoral program in Information Technology. Her PhD is from the University of Minnesota. Professor Zigurs' research examines design, implementation, and use of collaboration technologies, particularly in virtual teams and projects. She has published in such journals as *MIS Quarterly, Journal of Management Information Systems, International Journal of e-Collaboration*, and *Group Decision and Negotiation*, among others. She has co-published with Deepak Khazanchi a book on patterns of effectiveness in virtual projects. Professor Zigurs serves as Editor-in-Chief of *e-Service Journal*, and was formerly a Senior Editor for the *MIS Quarterly* and Department Editor for the *IEEE Transactions on Engineering Management*.